Skill Assessment of Multiple Hydrodynamic-Dissolved Oxygen Models in Chesapeake Bay

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ABSTRACT

The Chesapeake Bay is the largest, most productive, and most biologically diverse estuary in North America, providing crucial habitat and natural resources for a suite of native and migratory species while also serving as a home to over 16 million people. Over the last half-century, anthropogenic impacts, primarily via nutrient export to the Bay, have dramatically decreased water quality. Improving the health of the Chesapeake Bay has become a priority for the six states that make up the watershed, and together, they have committed to follow a nutrient reduction plan developed primarily by using a single modeling system. As Chesapeake Bay models are increasingly used in economic decisions and regulatory environmental protection applications related to estuarine water quality, it is important to understand the limitations and uncertainties associated with model projections of dissolved oxygen concentrations, the primary indicator used in assessing the health of the Chesapeake Bay. Utilization of a multiple model approach to management decisions regarding dissolved oxygen could enhance confidence in projections and better refine our understanding of uncertainty in those projections, ultimately increasing overall environmental intelligence. Quantitatively assessing model skill by a variety of metrics is necessary to compare the ability of models in a multiple models system. This study statistically compares historical Chesapeake Bay Program monitoring data to a set of coupled hydrodynamic-dissolved oxygen models of varying complexity to the Chesapeake Bay's official regulatory model in terms of hydrodynamics, dissolved oxygen, nutrients, and chlorophyll of the two year period of 2004-2005. Results show that although models have difficulty resolving primary influences on dissolved oxygen (stratification and nutrients), they all have significant skill in reproducing the mean and seasonal variability of bottom dissolved oxygen. This suggests that the environmental intelligence gleaned from a set of water quality model predictions of dissolved oxygen is not dependent on the ability of these models to resolve other physical and biological predictors. Our results also highlight the ability of even relatively simple dissolved oxygen models to provide reliable environmental intelligence.